

We claim:

1. A treatment of waste process comprises oxidizing mixed waste by (a) dissolution of transuranic elements plutonium, neptunium, americium, curium, and californium, and/or compounds thereof in transuranic waste (TRUW), low level waste (LLW), low level mixed waste (LLMW), special case waste (SCW), and greater than class C (GTCC) LLW; (b) destruction of non-fluorocarbon organic component in the waste ; or (c) decontamination of transuranic/actinide contaminated equipment, further comprising disposing an electrolyte in an electrochemical cell, separating the electrolyte into an anolyte portion and a catholyte portion with an ion-selective membrane or semi permeable membrane, applying a direct current voltage between the anolyte portion and the catholyte portion, placing the mixed waste and/or transuranic/actinides materials in the anolyte portion, and oxidizing the mixed waste and/or transuranic/actinides materials in the anolyte portion with a mediated electrochemical oxidation (MEO) process, wherein the anolyte portion further comprises a mediator oxidizing species in aqueous solution and containing an acid, neutral or alkaline electrolytes.

2. The process of claim 1, wherein the mediator oxidizing species is selected from the group of mediators described in Table I.

3. The process of claim 1, wherein the mediator oxidizing species are selected from one or more of a group of Type I complex anion redox couple isopolyanion mediators containing tungsten, molybdenum, vanadium, niobium, tantalum, or combinations thereof as addenda atoms in aqueous solution.

4. The process of claim 1, wherein the mediator oxidizing species are selected from one or more of a group of Type I heteropolyanions formed by incorporation into Type I isopolyanions, as heteroatoms, any of the elements listed in Table II, either singly or in combination thereof in the aqueous solution.

5. The process of claim 1, wherein the mediator oxidizing species are selected from one or more of a group of heteropolyanions containing at least one heteroatom type element contained in both Table I and Table II in the aqueous solution.

6. The process of claim 1, wherein the mediator oxidizing species are selected from a group of combinations of anion redox couple mediators described in Tables I and II, and wherein reduced forms of the redox

couples are reoxidized in the anolyte portion within the electrochemical cell.

7. The process of claim 1, further comprising introducing catalyst additives to the electrolyte and thereby increasing the kinetics of the mediated electrochemical processes while keeping the additives from becoming directly involved in the oxidizing of mixed waste materials.

8. The process of claim 1, further comprising adding stabilizing compounds to the electrolyte for overcoming and stabilizing the short lifetime of oxidized forms of higher oxidation state species of the mediator oxidizing species.

9. The process of claim 1, wherein the mediator oxidizing species are identified in Table I, and wherein each of the species has normal valence states and higher valence oxidizing states and further comprising creating the higher valence oxidizing states of the mediator oxidizing species by stripping electrons from normal valence state species in the electrochemical cell.

10. The process of claim 1, wherein the mediator oxidizing species are super oxidizers which exhibit oxidation potentials of at least 1.7 volts at 1 molar, 25°C and pH 1 and which are redox couple species that have the capability of producing free radicals of hydroxyl or perhydroxyl, and further comprising creating free radical secondary oxidizers by reacting the super oxidizers with water.

11. The process of claim 1, further comprising using an alkaline solution, aiding decomposing of the biological materials in mixed waste derived from base promoted ester hydrolysis, saponification, of fatty acids, and forming water soluble alkali metal salts of the fatty acids and glycerin in a process similar to the production of soap from animal fat by introducing it into a hot aqueous lye solution.

12. The process of claim 1, further comprising using an alkaline anolyte solution for absorbing CO₂ from the oxidizing of mixed waste materials and forming bicarbonate/carbonate solutions, which subsequently circulate through the electrochemical cell, producing percarbonate oxidizers.

13. The process of claim 1, wherein the mediator oxidizing species are super oxidizers, and further comprising generating inorganic free radicals in aqueous solutions from carbonate, azide, nitrite, nitrate,

phosphite, phosphate, sulfite, sulfate, selenite, thiocyanate, chloride, bromide, iodide, and formate oxidizing species.

14. The process of claim 1, wherein the membrane is microporous plastic, ion-selective, porous ceramic or sintered glass frit.

15. The process of claim 1, further comprising impressing an AC voltage upon the direct current voltage for retarding formation of cell performance limiting surface films on the electrodes or the membrane.

16. The process of claim 1, further comprising disposing a foraminous basket in the anolyte and holding the mixed waste in the basket.

17. The process of claim 1, wherein the catholyte portion contains HNO_3 or NO_3^- salts, and further comprising adding oxygen to the catholyte portion to suppress the formation of NO_x .

18. The process of claim 1, wherein the mediator oxidizing species is simple anions described in Table I, Type I isopolyanions containing tungsten, molybdenum, vanadium, niobium, tantalum, or combinations thereof as addenda atoms; Type I heteropolyanions formed by incorporation into the aforementioned isopolyanions, as heteroatoms, any of the elements listed in Table II, either singly or in combinations thereof; or any heteropolyanions containing at least one heteroatom type contained in both Table I and Table II.

19. The process of claim 1, further comprising adjusting temperature between 0°C and slightly below the boiling point of the anolyte portion before it enters the electrochemical cell for enhancing generation of oxidized forms of the mediator oxidizing species, and adjusting the temperature between 0°C and below the boiling temperature of the anolyte portion entering the anolyte reaction chamber affecting desired chemical reactions at desired rates.

20. The process of claim 1, further comprising introducing an ultrasonic energy into the anolyte portion, rupturing cell membranes in the biological materials in mixed waste by momentarily raising local temperature and pressure within the cell membranes with the ultrasonic energy to above several thousand degrees and thousand atmospheres, and causing cell membrane failure.

21. The process of claim 1, further comprising introducing ultraviolet energy into the anolyte portion and decomposing hydrogen

peroxide into hydroxyl free radicals therein, thereby increasing efficiency of the process by converting products of electron consuming parasitic reactions, ozone and hydrogen peroxide, into viable free radical secondary oxidizers without consumption of additional electrons.

22. The process of claim 1, further comprising adding a surfactant to the anolyte portion for promoting dispersion of the mixed waste or intermediate stage reaction products within the aqueous solution when the mixed waste or reaction products are not water-soluble and tend to form immiscible layers.

23. The process of claim 1, further comprising attacking specific organic molecules in the mixed waste with the mediator oxidizing species while operating at a sufficiently low temperatures and preventing formation of dioxins and furans.

24. The process of claim 1, further comprising breaking down the mixed waste materials into biological and organic compounds and attacking these compounds using as the mediator simple and/or complex anion redox couple mediators or inorganic free radicals and generating organic free radicals.

25. The process of claim 1, further comprising raising normal valence state mediator anions to a higher valence state by stripping the mediator anions of electrons in the electrochemical cell, wherein oxidized forms of weaker redox couples present in the mediator oxidizing species are produced by similar anodic oxidation or reaction with oxidized forms of stronger redox couples present and the oxidized species of the redox couples oxidize molecules of the mixed waste and are themselves converted to their reduced form, whereupon they are oxidized by the aforementioned mechanisms and the redox cycle continues.

26. A process for treating waste comprising oxidizing mixed waste materials by circulating anions of mediator oxidizing species in an electrolyte through an electrochemical cell and affecting anodic oxidation of reduced forms of reversible redox couples into oxidized forms, contacting the anions with the mixed waste materials in an anolyte portion of the electrolyte in a primary oxidation process, involving super oxidizer anions, having an oxidation potential above a threshold value of 1.7 volts at 1 molar, 25°C and pH1 creating a free radical oxidizer driven secondary oxidation process, adding energy from an energy source to the

anolyte portion and augmenting the secondary oxidation processes, breaking down hydrogen peroxide in the anolyte portion into hydroxyl free radicals, and increasing an oxidizing effect of the secondary oxidation processes.

27. The process of claim 26, wherein the adding energy comprises irradiating the anolyte portion with ultraviolet energy.

28. The process of claim 26, wherein the adding energy comprises introducing an ultrasonic energy source into the anolyte portion, irradiating cell membranes in the mixed waste, momentarily raising local temperature within the cell membranes, causing failure of the cell membranes, and creating greater exposure of cell contents in the mixed waste to oxidizing species in the anolyte portion.

29. The process of claim 26, wherein the adding energy comprises introducing an ultrasonic energy source and/or an ultraviolet energy source into the anolyte portion, promoting formation of the hydroxyl free radicals.

30. The process of claim 26, wherein the mediator oxidizing species are simple anions redox couple mediators described in Table I; Type I isopolyanions formed by Mo, W, V, Nb, Ta, or mixtures thereof; Type I heteropolyanions formed by incorporation into the isopolyanions if any of the elements listed in Table II (heteroatoms) either singly or in thereof, or heteropolyanions containing at least one heteroatom type element contained in both Table I and Table II or combinations of the mediator oxidizing species from any or all of these generic groups.

31. The process of claim 26, further comprising using the mediator oxidizing species that are found in situ in the mixed waste to be decomposed, by circulating the mixed waste-anolyte mixture through the electrochemical cell wherein an oxidized form of an in situ reversible redox couple is formed by anodic oxidizing or reacting with an oxidized form of a more powerful redox couple added to or already present in the anolyte portion and anodically oxidized in the electrochemical cell, thereby destroying biological and organic materials in the mixed waste.

32. The process of claim 26, further comprising using an alkaline electrolyte selected from a group consisting of NaOH or KOH and combinations thereof, with the mediator oxidizing species, wherein a reduced form of a mediator redox couple has sufficient solubility in said

electrolyte for allowing desired oxidation of biological and organic materials in the mixed waste.

33. The process of claim 26, wherein the oxidation potential of redox reactions of the mediator oxidizing species and the biological and organic molecules in the mixed waste producing hydrogen ions are inversely proportional to electrolyte pH, and thus with a selection of a mediator redox couple increasing the electrolyte pH reduces the electric potential required, thereby reducing electric power consumed per unit mass of the mixed waste destroyed.

34. The process of claim 26, wherein the electrolyte is an aqueous solution chosen from acids, alkalines and neutral electrolytes and mixtures thereof.

35. The process of claim 26, wherein the added energy comprises using ultrasonic energy and inducing microscopic bubble expansion and implosion for reducing in size individual second phase mixed waste volumes dispersed in the anolyte .

36. The process of claim 26, further comprising interchanging the mediator oxidizing species without changing equipment, and wherein the electrolyte is an acid, neutral or alkaline aqueous solution.

37. The process of claim 26, further comprising separating the anolyte portion and a catholyte portion of the electrolyte with a hydrogen or hydronium ion-permeable membrane, microporous polymer, porous ceramic or glass frit membrane.

38. The process of claim 26, further comprising electrically energizing the electrochemical cell at a potential level sufficient for forming the oxidized forms of redox couples having highest oxidizing potential in the anolyte, introducing the mixed waste into the anolyte portion, forming reduced forms of one or more reversible redox couples by contacting with oxidizable molecules, reacting and oxidizing oxidizable material with concomitant reduction of the oxidized forms of the reversible redox couples to their reduced forms, and wherein the adding energy comprises providing an ultrasonic source connected to the anolyte portion for augmenting secondary oxidizing processes by momentarily heating the hydrogen peroxide in the electrolyte to 4800°C at 1000 atmospheres thereby dissociating the hydrogen peroxide into hydroxyl free radicals thus increasing the oxidizing.

39. The process of claim 38, wherein oxidation potentials of redox reactions producing hydrogen ions are inversely related to pH;

40. The process of claim 26, wherein the process is performed at a temperature from slightly above 0°C to slightly below the boiling point of the electrolyte.

41. The process of claim 40, wherein the temperature at which the process is performed is varied.

42. The process of claim 26, wherein the oxidizing and destroying mixed waste materials comprises destroying and oxidizing solid mixed waste.

43. The process of claim 26, wherein the oxidizing and destroying mixed waste materials comprises oxidizing and destroying liquid mixed waste.

44. The process of claim 26, wherein the oxidizing and destroying mixed waste materials comprises oxidizing and destroying a combination of liquids and solids in mixed waste.

45. The process of claim 26, further comprising requiring removing and treating precipitates resulting from combinations of the oxidizing species and other species released from the mixed waste during destruction and sterilization.

46. The process of claim 26, further comprising a catholyte portion of the electrolyte, and wherein the anolyte and catholyte portions of electrolyte are independent of one another, and comprise aqueous solutions of acids, alkali or neutral salt.

47. The process of claim 26, further comprising separating a catholyte portion of the electrolyte from the anolyte portion with a membrane, operating the electrochemical cell at a higher current density across the membrane, and near a limit over which there is the possibility that metallic anions may leak through the membrane in small quantities, and recovering the metallic anions through a resin column, thus allowing a greater rate of destruction of mixed waste materials in the anolyte portion.

48. The process of claim 47, wherein the catholyte portion further comprises an aqueous solution and the electrolyte in the solution is composed of acids, alkali or neutral, and further comprising adding oxygen to the solution when HNO_3 or NO_3^- can occur in the catholyte portion,

controlling concentration of electrolyte in the catholyte to maintain conductivity of the catholyte portion desired in the electrochemical cell, providing mechanical mixing and/or ultrasonic energy induced microscopic bubble formation, and implosion for vigorous mixing in the catholyte solution for oxidizing the nitrous acid and small amounts of nitrogen oxides NO_x , introducing air into the catholyte portion for promoting the oxidizing of the nitrous acid and the small amounts of NO_x , and diluting any hydrogen produced in the catholyte portion before releasing the air and hydrogen.

49. Apparatus for the use of a treatment of waste process comprises oxidizing mixed waste by (a) dissolution of transuranic elements plutonium, neptunium, americium, curium, and californium, and/or compounds thereof in transuranic waste (TRUW), low level waste (LLW), low level mixed waste (LLMW), special case waste (SCW), and greater than class C (GTCC) LLW; (b) destruction of non-fluorocarbon organic component in the waste ; or (c) decontamination of transuranic/actinide contaminated equipment, further comprising an electrochemical cell, an aqueous electrolyte disposed in the electrochemical cell, a hydrogen or hydronium ion-permeable or selective membrane, disposed in the electrochemical cell for separating the cell into anolyte and catholyte chambers and separating the electrolyte into aqueous anolyte and catholyte portions, electrodes further comprising an anode and a cathode disposed in the electrochemical cell respectively in the anolyte and catholyte chambers and in the anolyte and catholyte portions of the electrolyte, a power supply connected to the anode and the cathode for applying a direct current voltage between the anolyte and the catholyte portions of the electrolyte, and oxidizing of the materials in the anolyte portion with a mediated electrochemical oxidation (MEO) process wherein the anolyte portion further comprises a mediator in aqueous solution for producing reversible redox couples used as oxidizing species and the electrolyte is an acid, neutral or alkaline aqueous solution.

50. The apparatus of claim 49, further comprising an anolyte reaction chamber and buffer tank housing the bulk of the anolyte solution, an input pump to enter liquid mixed waste materials into the anolyte reaction chamber, a spray head and stream head to introduce the anolyte from the electrochemical cell into the anolyte reaction chamber in such a

56. The apparatus of claim 49, wherein the anolyte portion further comprises super oxidizers generating inorganic free radicals in aqueous solutions derived from carbonate, azide, nitrite, nitrate, phosphite, phosphate, sulfite, sulfate, selenite, thiocyanate, chloride, bromide, and iodide species, anions with an oxidation potential above a threshold value of 1.7 volts at 1 molar, 25°C and pH1 (i.e., super oxidizer) for involving in a secondary oxidation process for producing oxidizers, and organic free radicals for aiding the process and breaking down the mixed materials into simpler smaller molecular structure biological and organic compounds.

57. The apparatus of claim 49, further comprising an ultrasonic energy source within or near the anolyte chamber for producing microscopic bubbles and implosions for reducing in size individual second phase mixed waste volumes dispersed in the anolyte.

58. The apparatus of claim 49, wherein the membrane is made of microporous polymer, porous ceramic or glass frit.

59. The apparatus of claim 48, further comprising an AC source for impression of an AC voltage upon the DC voltage to retard the formation of cell performance limiting surface films on the electrodes and/or membranes.

60. The apparatus of claim 49, further comprising an air sparge connected to the catholyte reservoir, whereby oxygen contained in the air oxidizes nitrous acid and the small amounts of nitrogen oxides (NO_x), produced by cathode reactions when HNO_3 or NO_3^- salts are present in the catholyte.

61. The apparatus of claim 49, wherein each of the mediator oxidizing species has normal valence states in reduced forms of redox couples and higher valence oxidizing states oxidized forms of redox couples of the mediator oxidizing species created by stripping and reducing electrons off normal valence state species in the electrochemical cell.

62. The apparatus of claim 49, wherein the anolyte portions are alkaline solutions and oxidation potentials of redox reactions producing hydrogen ions are inversely related to pH, which reduces the electrical power required to oxidize and destroying the mixed waste.

63. The apparatus of claim 49, wherein the mediator oxidizing species attack specific organic molecules in the mixed waste while

operating at temperatures sufficiently low so as to preventing the formation of dioxins and furans.

64. The apparatus of claim 49, wherein the power supply energizes the electrochemical cell at a potential level sufficient to form the oxidized form of the redox couple having the highest oxidation potential in the anolyte, and further comprising a heat exchanger connected to the anolyte chamber for controlling temperature between 0°C and slightly below the boiling temperature of the anolyte with the heat exchanger before the anolyte enters the electrochemical cell enhancing the generation of oxidized forms of the anion redox couple mediator, and adjusting the temperature of the anolyte to the range between 0°C and slightly below the boiling temperature when entering the anolyte reaction chamber.

65. The apparatus of claim 49, wherein the mediator oxidizing species are one or more Type I isopolyanion complex anion redox couple mediators containing tungsten, molybdenum, vanadium, niobium, tantalum, or combinations thereof as addenda atoms in aqueous solution;

66. The apparatus of claim 65, wherein the mediator oxidizing species are one or more Type I heteropolyanions formed by incorporation into the isopolyanions, as heteroatoms, of the elements listed in Table II, either singly or in combination thereof.

67. The apparatus of claim 49, wherein the mediator oxidizing species are one or more heteropolyanions containing at least one heteroatom type element contained in Table I and Table II.

68. The apparatus of claim 49, wherein the mediator oxidizing species are higher valence state of species found in situ for destroying of mixed waste materials.

69. The apparatus of claim 49, wherein the membrane is hydrogen or hydronium ion semi permeable or ion-selective, microporous polymer, porous ceramic or glass frit membrane for separating the anolyte portion and the catholyte portion while allowing hydrogen or hydronium ion passage from the anolyte to the catholyte.

70. The apparatus of claim 49, wherein oxidation potentials of redox reactions producing hydrogen ions are inversely related to pH, the mixed waste is liquid or solid, or a combination of liquids and solids, and the oxidizing species are interchangeable without changing other elements of the apparatus.

71. The apparatus of claim 49, further comprising an ultraviolet source connected to the anolyte chamber for decomposing hydrogen peroxide into hydroxyl free radicals as secondary oxidizers and increasing efficiency of the process by recovering energy through the oxidation of the mixed waste materials in the anolyte chamber by the secondary oxidizers.

72. The apparatus of claim 49, further comprising an ultrasonic source connected to the anolyte for augmenting secondary oxidation processes by heating hydrogen peroxide containing electrolyte to 4800°C, at 1000 atmospheres for dissociating hydrogen peroxide into hydroxyl free radicals and thus increasing concentration of oxidizing species and rate of waste destruction and for irradiating cell membranes in biological materials in the mixed waste to momentarily raise the temperature within the cell membranes to above several thousand degrees, causing failure of the cell membranes, and creating greater exposure of cell contents to oxidizing species in the anolyte.

73. The apparatus of claim 49, further comprising use of ultrasonic energy, via the ultrasonic energy source communicating with the anolyte for inducing microscopic bubble implosions to affect a reduction in size of the individual second phase waste volumes dispersed in the anolyte.

74. The apparatus of claim 49, further comprising an anolyte reaction chamber holding most of the anolyte portion and a foraminous basket, a penetrator attached to the basket to puncture solids increasing the exposed area, and further comprising an external CO₂ vent connected to the reaction chamber for releasing CO₂ into the atmosphere, a hinged lid attached to the reaction chamber allowing insertion of waste into the anolyte portion as liquid, solid, or mixtures of liquids and solids, an anolyte pump connected to the reaction chamber, an inorganic compounds removal and treatment system connected to the anolyte pump for removing chlorides, and other precipitate forming anions present in biological and organic waste being processed, thereby precluding formation of unstable oxycompounds.

75. The apparatus of claim 74, further comprising an off-gas cleaning system, comprising scrubber/absorption columns connected to the vent, a condenser connected to the anolyte reaction chamber, whereby non-

condensable incomplete oxidation products, low molecular weight organics and carbon monoxide are reduced to acceptable levels for atmospheric release by the gas cleaning system, and wherein the anolyte off-gas is contacted in the gas cleaning system wherein the noncondensibles from the condenser are introduced into the lower portion of the gas cleaning system through a flow distribution system and a small side stream of freshly oxidized anolyte direct from the electrochemical cell is introduced into the upper portion of the column, resulting in a gas phase continuously reacting with the oxidizing mediator species as it rises up the column past the down flowing anolyte, and external drain, for draining to an organic compound removal system and the inorganic compounds removal and treatment system, and for draining the anolyte system, wherein the organic compounds recovery system is used to recover mixed waste materials that are benign and do not need further treatment, and mixed waste materials that will be used in the form they have been reduced.

76. The apparatus of claim 74, further comprising thermal control units connected to heat or cool the anolyte to a selected temperature range when anolyte is circulated into the reaction chamber through the electrochemical cell by pump on the anode chamber side of the membrane, a flush for flushing the anolyte, and a filter is located at the base of the reaction chamber to limit the size of exiting solid particles to approximately 1mm in diameter.

77. The apparatus of claim 49, wherein the direct current for the electrochemical cell is provided by a DC power supply, which is powered by an AC power supply, and wherein the DC power supply is low voltage high current supply operating at or below 10V DC and the AC power supply operates off an about 110v AC line for the smaller units and about 240v AC for larger units.

78. The apparatus of claim 49, further comprising an electrolyte containment boundary composed of materials resistant to the oxidizing electrolyte selected from a group consisting of stainless steel, PTFE, PTFE lined tubing, glass and ceramics, and combinations thereof.

79. The apparatus of claim 49, further comprising an anolyte recovery system connected to a catholyte pump, a catholyte reservoir connected to the cathode portion of the electrochemical cell, a thermal control unit connected to the catholyte reservoir for varying the

temperature of the catholyte portion, a bulk of the catholyte portion being resident in a catholyte reservoir, wherein the catholyte portion of the electrolyte flows into a catholyte reservoir, and further comprising an air sparge connected to the catholyte reservoir for introducing air into the catholyte reservoir.

80. The apparatus of claim 79, further comprising an anolyte recovery system for capturing the anions and for reintroducing the anions into the anolyte chamber upon collection from the catholyte electrolyte, an off-gas cleaning system connected to the catholyte reservoir for cleaning gases before release into the atmosphere, and an atmospheric vent connected to the off-gas cleaning system for releasing gases into the atmosphere, wherein cleaned gas from the off-gas cleaning system is combined with unreacted components of the air introduced into the system and discharged through the atmospheric vent 47.

81. The apparatus of claim 79, further comprising a screwed top on the catholyte reservoir to facilitate flushing out the catholyte reservoir, a mixer connected to the catholyte reservoir for stirring the catholyte, a catholyte pump connected to the catholyte reservoir for circulating catholyte back to the electrochemical cell, a drain for draining catholyte, a flush for flushing the catholyte system, and an air sparge connected to the housing for introducing air into the catholyte reservoir, wherein the catholyte portion of the electrolyte is circulated by pump through the electrochemical cell on the cathode side of the membrane, and wherein contact of oxidizing gas with the catholyte portion of the electrolyte is enhanced by promoting gas/liquid contact by mechanical and/or ultrasonic mixing.

82. The apparatus of claim 49, wherein the electrochemical cell is operated at high membrane current densities for increasing a rate of mixed waste destruction, also results in increased mediator ion transport through the membrane into the catholyte, and further comprising an anolyte recovery system positioned on the catholyte side, air sparging on the catholyte side to dilute and remove off-gas and hydrogen, wherein some mediator oxidizer species cross the membrane and are removed through the anolyte recovery system to maintain process efficiency or cell operability.

83. The apparatus of claim 49, further comprising a controller, a microprocessor, a monitor and a keyboard connected to the cell for inputting commands to the controller through the keyboard responding to the information displayed on the monitor, a program in the controller sequencing the steps for operation of the apparatus, program having pre-programmed sequences of operations the operator follows or chooses other sequences of operations, the controller allows the operator to select sequences within limits that assure a safe and reliable operation, the controller sends digital commands that regulate electrical power to pumps, mixers, thermal controls, ultraviolet sources, ultrasonic sources, CO₂ vents, air sparge, and the electrochemical cell, the controller receives component response and status from the components, the controller sends digital commands to the sensors to access sensor information through sensor responses, sensors in the apparatus provide digital information on the state of components, sensors measure flow rate, temperature, pH, CO₂ venting, degree of oxidation, and air sparging, the controller receives status information on electrical potential across the electrochemical cell or individual cells in a multi-cell configuration and between reference electrodes internal to the anolyte and catholyte chambers of the electrochemical cells and the current flowing between the electrodes within each cell.

84. A mixed waste destruction system which, comprising a housing constructed of metal or high strength plastic surrounding an electrochemical cell, electrolyte and a foraminous basket in the cell, an AC power supply with a power cord, a DC power supply connected to the AC power supply, the DC power supply providing direct current to the electrochemical cell, an anolyte reaction chamber with a basket, an air sparge for introducing air into a catholyte reservoir below a surface of a catholyte, a CO₂ vent incorporated into the housing to allow for CO₂ release from the anolyte reaction chamber, an atmospheric vent facilitating the releases of gases into the atmosphere from the catholyte reservoir, a hinged lid for opening and depositing the organic waste in the basket in the anolyte reaction chamber, a locking latch connected to the hinged lid, and in the anolyte reaction chamber an anolyte portion further comprising an aqueous acid, alkali, or neutral salt electrolyte and mediated oxidizer species solution in which an oxidizer form of a

mediator redox couple initially may be present or may be generated electrochemically after introduction of the waste and application of DC power to the electrochemical cell, a controller with a control keyboard for input of commands and data, a monitor screen to display operations and functions of the systems, status lights for displaying information about status of the treatment of the mixed waste material, 85. The system of claim 84, wherein the mixed waste is introduced when the anolyte is at room temperature, operating temperature or intermediate temperature, and the mixed waste material is rapidly oxidized at temperatures below boiling point of the anolyte portion, at ambient pressure, and further comprising a pump circulating the anolyte portion of the electrolyte, an in-line filter preventing solid particles large enough to clog electrochemical cell flow paths from exiting the reaction chamber, an inorganic compound removal and treatment system and drain outlets connected to the anolyte reaction chamber, whereby residue is pacified in the form of a salt and periodically removed, and a removable top connected to a catholyte reservoir allowing access to the reservoir for cleaning and maintenance.

86. A mixed waste oxidizing process, comprising an operator engaging an 'ON' button on a control keyboard, a system controller which further comprises a microprocessor, running a program and controlling a sequence of operations, a monitor screen displaying process steps in proper sequence, status lights on a panel providing status of the process, opening a lid and placing the mixed waste in a basket as a liquid, solid, or a mixture of liquids and solids, retaining a solid portion of the mixed waste and flowing a liquid portion through the basket and into an anolyte reaction chamber, activating a locking latch after the mixed waste is placed in the basket, activating pumps and circulating anolyte and catholyte, once the circulating is established throughout the system, operating mixers, once flow is established, turning on thermal control units, and initiating anodic oxidizing and electrolyte heating programs, energizing an electrochemical cell to electric potential and current density determined by the program of the controller, using programmed electrical power and electrolyte temperature ramps for maintaining a predetermined mixed waste destruction rate profile as a relatively constant reaction rate as more reactive waste components are oxidized, thus resulting in the remaining waste becoming less and less reactive,

providing more vigorous oxidizing conditions by activating ultrasonic and ultraviolet systems in the anolyte reaction chamber and catholyte reservoir, releasing CO₂ from the biological and organic materials in the mixed waste oxidizing process in the anolyte reaction chamber, activating air sparge and atmospheric vent in a catholyte system, monitoring progress of the process in the controller by cell voltages and currents, monitoring CO₂, CO, and O₂ gas composition for CO₂, CO and oxygen content, decomposing the mixed waste into water and CO₂, the latter being discharged out of the CO₂ vent, air sparging drawing air into a catholyte reservoir, and discharging excess air out of an atmospheric vent, determining with an oxidation sensor that desired degree of mixed waste destruction has been obtained, setting the system to standby, and executing system shutdown using the controller keyboard system operator.

87. The process of claim 86, further comprising placing the system in a standby mode during the day and adding mixed waste as it is generated throughout the day, placing the system in full activation during non-business hours, operating the system at low temperature and ambient atmospheric pressure and not generating toxic compounds during the oxidation of the mixed waste, making the process indoors compatible, scaling the system between units small enough for use by a single practitioner and units large enough for replacing hospital incinerators, releasing CO₂ oxidation product from the anolyte system out through the CO₂ vent, and venting off-gas products from the catholyte reservoir through the atmospheric vent.

88. The process of claim 86, further comprising introducing the mixed waste into a room temperature or cooler system with little or none of the mediator redox couple in the oxidizer form, depending upon reaction kinetics, heat of reaction and similar waste characteristics.